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| 09/902,483      | 07/11/2001  | Cyril Cabral JR.     | YO999-408 CIP       | 7319             |

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EXAMINER

KIELIN, ERIK J

ART UNIT

PAPER NUMBER

2813

12

DATE MAILED: 10/01/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application N .

09/902,483

Applicant(s)

CABRAL ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 14 May 2002.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-8, 10-13 and 23-26 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-8, 10-13 and 23-26 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☒ The proposed drawing correction filed on 14 May 2002 is: a) ☒ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

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## DETAILED ACTION

### *Drawings*

1. The proposed drawing correction and/or the proposed substitute sheets of drawings, filed on 14 May 2002 have been approved. A proper drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The correction to the drawings will not be held in abeyance.

## INFORMATION ON HOW TO EFFECT DRAWING CHANGES

### 1. Correction of Informalities -- 37 CFR 1.85

New corrected drawings must be filed with the changes incorporated therein. Identifying indicia, if provided, should include the title of the invention, inventor's name, and application number, or docket number (if any) if an application number has not been assigned to the application. If this information is provided, it must be placed on the front of each sheet and centered within the top margin. If corrected drawings are required in a Notice of Allowability (PTOL-37), the new drawings **MUST** be filed within the **THREE MONTH** shortened statutory period set for reply in the "Notice of Allowability." Extensions of time may NOT be obtained under the provisions of 37 CFR 1.136 for filing the corrected drawings after the mailing of a Notice of Allowability. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

### 2. Corrections other than Informalities Noted by Draftsperson on form PTO-948.

All changes to the drawings, other than informalities noted by the Draftsperson, **MUST** be made in the same manner as above except that, normally, a highlighted (preferably red ink) sketch of the changes to be incorporated into the new drawings **MUST** be approved by the examiner before the application will be allowed. No changes will be permitted to be made, other than correction of informalities, unless the examiner has approved the proposed changes.

### Timing of Corrections

Applicant is required to submit acceptable corrected drawings within the time period set in the Office action. See 37 CFR 1.185(a). Failure to take corrective action within the set (or extended) period will result in **ABANDONMENT** of the application.

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***Claim Rejections - 35 USC § 112***

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 1-8, 10-13, and 26 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The claims are considered indefinite because the phrase "metal containing silicon or alloy thereof" is unclear, as presently written, because it is unclear if metal alloy is distinct from metal containing silicon or if the alloy is intended to contain silicon also. This must be made clear.

4. Claims 5 and 6 are further considered indefinite because it requires a blanket deposition of plane metal Co, Ti, or Ni, none of which meet the requirement of metal alloy or metal containing silicon as required in claim 4, from which claim 5 depends.

***Claim Rejections - 35 USC § 102***

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in-

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

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6. Claim 25 is rejected under 35 U.S.C. 102(e) as being anticipated by US 6,165,903 (Besser et al.).

Regarding independent claims, Besser discloses a silicon substrate 30, which is bulk silicon (Fig. 4);

depositing a metal layer 42 which may be cobalt (Co) or titanium (Ti) (Fig. 5);

reacting the Co layer to form a first silicide phase layer (CoSi) 44, using RTA (rapid thermal annealing) (Fig. 6; col. 4, line 63 to col. 5, line 4);

selectively etching any unreacted Co while leaving behind the silicide 44 (Fig. 7; col. 5, lines 19-24);

depositing a silicon cap layer 46 (Fig. 8; col. 5, lines 25-28), without using epitaxial processes (col. 5, lines 36-40);

reacting the cap layer to form a second silicide phase layer (CoSi<sub>2</sub>) 48 using RTA (Fig. 9, col. 5, lines 49-63); and

etching any unreacted silicon cap layer (Fig. 10; col. 6, lines 9-12).

(See also col. 4, line 38 to col. 6, line 24 for the entire process.)

7. Claim 25 is rejected under 35 U.S.C. 102(e) as being anticipated by Patent Application Publication US 2002/0009856 A1 (Kanamori).

Kanamori discloses a substrate having a silicon layer (an SOI, or silicon-on-insulator substrate, as further limited in instant claim 3) 112, 114, 116 (Figs. 2A); depositing a cobalt (Co) metal layer 126 (Fig. 2B) to a thickness of 5-12 nm (paragraph [0030]); depositing a TiN cap 128 on the Co layer; reacting the Co layer to form a first silicide (CoSi) 130, 132 using rapid thermal annealing (RTA) (Fig. 2C; paragraph [0031]); etching any unreacted Co and capping TiN (last

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sentence of paragraph [0031]); depositing a silicon cap layer (poly-Si) 136 (Fig. 2D) without using epitaxial processes (paragraph [0032]); reacting the cap layer to form a second silicide phase ( $\text{CoSi}_2$ ) 138, 140 using RTA (paragraph [0033]) and etching any unreacted silicon cap layer (Fig. 2E; paragraph [0034], [0042]). (See also paragraphs [0028] through [0035].)

Note that the same process is shown for Ti metal with an amorphous silicon cap layer (a-Si) which is etched off after the second reacting (rapid thermal anneal, RTA) step. (See Figs. 3A-3E and associated paragraphs [0036] through [0043].)

### *Claim Rejections - 35 USC § 103*

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

9. Claims 1, 2, 23, and 4, 5, 8, 12, 24, and 10, 13, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Besser** in view of US 5,828,131 (**Cabral, Jr. et al.**).

The prior art of **Besser**, as explained above, discloses each of the claimed features except for indicating if a metal alloy or metal alloy containing silicon was deposited to form the silicide.

**Cabral** teaches the benefits of using metal alloys which contain silicon to form silicides on silicon layers. (See Abstract; col. 6, lines 4-16.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Besser** to use an alloy as taught by **Cabral** because **Cabral** teaches that the metal

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alloy provides greater thermal stability to the silicide than the pure metal alone. (See col. 11, lines 4-11.)

10. Claims 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Besser** in view of Patent Application US 2002/0106879 A1 (**Akram**).

The prior art of **Besser**, as explained above, discloses each of the claimed features except for indicating if a metal alloy or metal alloy containing silicon was deposited to form the silicide.

**Akram** teaches a method of forming silicides by depositing metal and metal alloys including silicides (paragraphs [0034] and [0039]).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to using a metal containing silicon, specifically as cobalt-silicon alloy to form the silicide of **Besser** as a matter of design choice since it appears that metal, metal alloy, or metal containing silicon would each work equally well to form the silicide. One of ordinary skill would be especially motivated to use the cobalt containing silicon to reduce silicon consumption of the substrate in **Besser** and thereby to form shallow junctions. Reduced consumption would necessarily be the result of including silicon with the cobalt initially deposited to form the silicide layer, thereby preventing silicon from the substrate from being used.

Although the atom ratio of the cobalt containing silicon is not taught to be  $\text{Co} > 0.7$  and  $\text{Si} < 0.3$ , it would be obvious to use such a ratio as a matter of routine optimization, noting that the cobalt-silicon layer would have to be cobalt-rich, since further annealing would necessarily lead to the correct stoichiometric ratio  $\text{CoSi}_2$  having a lower amount of cobalt relative to silicon,

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since it would necessarily be reacting with the silicon substrate in the first anneal phase, as required in **Besser**. (See MPEP 2144.05.)

11. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Besser** in view of **Akram** and **Kanamori**.

The prior art of **Besser** in view of **Akram**, as explained above, discloses each of the claimed features except for indicating the thickness of the cobalt silicide layer.

As noted above, **Kanamori** discloses a Co layer thickness of 5-12 nm which is broader than the 7-8 nm range than presently claimed. However, it has been held that the selection of optimum ranges within prior art general conditions is obvious, in the absence of evidence of unexpected results relative to the prior art range. (See MPEP 2144.05.)

It would have been obvious to one of ordinary skill at the time of the invention to optimize the thickness range in **Kanamori** for use in the silicide layer formed in **Besser** in view of **Akram** in order to achieve the objective in **Kanamori** of reduced silicon consumption.

12. Claims 1, 3, 23 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Kanamori** in view of **Cabral**.

The prior art of **Kanamori**, as explained above, discloses each of the claimed features except for indicating if a metal alloy or metal alloy containing silicon was deposited to form the silicide.

**Cabral** teaches the benefits of using metal alloys which contain silicon to form silicides on silicon layers. (See Abstract; col. 6, lines 4-16.)



It would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Kanamori** to use an alloy as taught by **Cabral** because **Cabral** teaches that the metal alloy provides greater thermal stability to the silicide than the pure metal alone. (See col. 11, lines 4-11.)

13. Claims 2, and 4, 5, 7, 8, 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Kanamori** in view of **Cabral** as applied to claim 1 above, and further in view of **Besser**.

Regarding claims 2 and 4, 5, the prior art of **Kanamori**, as explained above, teaches all of the features of the claims except for using a bulk silicon substrate. **Besser** teaches virtually the same method as in **Kanamori**, but the process is performed on a bulk silicon substrate, for the same purpose: to reduce silicon consumption during silicide formation thereby preventing the associated problems (**Kanamori**, paragraph [0027]; **Besser**, first sentence of Abstract). Accordingly, it would be an obvious matter of design choice to perform the method of **Kanamori** on a bulk silicon substrate, as **Besser** has taught, in order to reduce silicon consumption on bulk silicon substrates, as desired in **Besser**.

Regarding claim 7, as indicated above, the TiN cap layer is disclosed.

Regarding claim 8, as indicated above, the first and second RTA steps are disclosed.

Regarding claim 12, as indicated above, the polysilicon or amorphous silicon is deposited using CVD -- not epitaxial processes.

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*Response to Arguments*

14. Applicant's arguments with respect to all claims have been considered but are moot in view of the new ground(s) of rejection.

*Conclusion*

This action is non-final so that Applicant may respond to the new grounds of rejection.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached at 703-306-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin

September 27, 2002